计算力学学报
Chinese Journal of Computational Mechanics

王东东,轩军厂,张灿辉.几何精确NURBS有限元中边界条件施加方式对精度影响的三维计算分析[J].计算力学学报,2012,29(1):31~37

几何精确NURBS有限元中边界条件施加方式对精度影响的三维计算分析

A three dimensional computational investigation on the influence of essential boundary condition imposi in NURBS isogeometric finite element analysis

投稿时间： 2010-01-05 最后修改时间： 2010-04-22

DOI：10.7511/jslx20121006

中文关键词： NURBS有限元法 几何精确分析 无网格法 罚函数法 位移边界条件

英文关键词:NURBS finite element method isogeometric analysis meshfree method penalty method essential boundary condition

基金项目:国家自然科学基金(10972188, 10602049); 教育部新世纪优秀人才支持计划(NCET-09-0678) 资助项目.

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中文摘要:

非均匀有理B样条(NURBS)有限元法把计算机辅助几何设计(CAGD)中的NURBS几何构形方法与有限元方法有机结合起来,有效消除了有限元离散模型的几何误差,提高了计算精度是由于NURBS基函数不是插值函数,直接在控制节点上施加位移边界条件会引起较大误差。本文详细讨论了NURBS基函数的插值特性,在NURBS有限元分析中采用罚函数法施加位移边界提高了收敛率和计算精度。结合典型三维弹性力学问题,对两种施加位移边界条件的方法进行了对比和分析。计算结果表明,直接施加位移边界条件会导致收敛率和精度的明显降低于罚函数法的NURBS有限元分析则能达到最优收敛率,并具有更高的精度。

英文摘要:

The NURBS isogeometric finite element analysis provides a perfect unification of the non-uniform rational B-spline (NURBS) functions used for computer geometry design and the finite element methodology. In this method the geometric modeling error is significantly reduced with improved solution accuracy. Nevertheless the NURBS basis functions commonly are not interpolatory functions and consequently the way of direct imposition of essential boundary conditio the control points may yield noticeable solution errors. In this work the interpolation property of NURBS basis functions is discussed in details and therea penalty formulation with improved solution accuracy and convergence behavior is proposed to enforce the essential boundary conditions in NURBS isogeometric analysis of three dimensional elasticity problems. Numerical results demonstrate that the approach with direct boundary condition enforcement on the control variables produces much larger solution errors as well as lower displacement and strain energy convergence rates,while the proposed method is capable of ach the optimal convergence rates simultaneously with superior accuracy.

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